

# PROCEEDING BOOK I



## bio energy chemicals materials BioENCHE 2013

International Seminar on Chemical Engineering  
In conjunction with  
Seminar Teknik Kimia Soehadi Reksowardoyo ( STKSRS ) 2013

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CODE	TITLE	AUTHORS	
BD.23	Experiment on Hydroxy (HHO) Gas Addition on Performance and Exhaust Gas Emissions of a Compression Ignition Engine Fuelled with Rubber Seed Methyl Ester	Iman K. Reksowardojo, Ratnak Sok, Tirta Prakoso, Toshio Shudo, Wiranto Arismunandar, Sovanna Pan	181

**BIOETHANOL**

CODE	TITLE	AUTHORS	
BE.02	Bioethanol Production Comparison of Elephant Grass and Liquid Waste Plant Wheat Boga Sari	Ni Ketut Sari, C. Pujiastuti, I Nyoman Abdi	191
BEP.01	Analysis on Chemical Components of Woods to Predict Ethanol Production Values	Wahyu Dwianto, Fitria, Ika Wahyuni, Danang Sudarwoko Adi, Rumi Kaida, Takahisa Hayashi	209

**BIOMASS GASIFICATION**

CODE	TITLE	AUTHORS	
BMG.01/ BMGP.01	IMPLEMENTATION OF BIOMASS GASIFICATION TECHNOLOGY IN NATURAL RUBBER PROCESSING SECTOR	Didin Suwardin	217
BMG.04	Design, Simulation and Experiments of Circulating Fluidized Bed Reactor for Biomass Gasification	Dr. Haifa Wahyu, Ir. Imam Djunaedi, Ir. M. Affendi, Ir. Sugiyatno, MT	227
BMG.05	Scaling-up and Implementation of Circulating Fluidized Bed Gasifier for Biomass Gasification in Siak Region	Dr. Haifa Wahyu	243

**BIOHYDROGEN**

CODE	TITLE	AUTHORS	
BH.01	Effect of Agitation Condition on BioHydrogen Production in Stirred Tank Reactor	Tantular Nurtuno, Christina Wahyu Kartikowati, Wa Ode Cakranirwana, Widiyastuti, Sugeng Winardi	255
BH.02	Dynamic Separation of Hydrogen from Producer Gas Using Pd-Ag Membrane	Yogi Wibisono Budhi, Rusdi, Irwan Noezar, Allan A.B. Padama, and Hideaki Kasai	265

International Seminar on Biorenewable Resources Utilization for Energy and Chemicals 2013  
In conjunction with Chemical Engineering Seminar of SoehadiReksowardojo 2013

## Bioethanol Production Comparison of Elephant Grass and Liquid Waste Plant Wheat Boga Sari

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**Abstract.** The availability of elephant grass and liquid waste plant wheat Boga Sari can be maintained continuous and also available in huge volume. It is raw material which is less attention, after raw material analysis, has cellulose, glucose, and starch contain, where both the raw materials have potential as bioethanol. This study has the objective to produce bioethanol and bioethanol as well as an industrial prototype as a reference in developing bioethanol industry in Indonesia. Bioethanol production process includes raw material hydrolysis with HCl, reducing sugar fermentation by bacteria of *Saccharomyces Cerevisiae*, and batch distillation process. Ethanol quality is affected by cellulose, starch, glucose in raw material. With the comparison obtained can be used as a basis for the design of a prototype bioethanol production processes and equipment. Raw materials to produce bio-ethanol showed that the levels of (95-96) % with a yield (31.69 - 33.3) %, by knowing process comparison, in order to obtain scale distillation column design mini plant with 100 liter scale ethanol/day in 3 batches. Raw materials economically liquid waste plant wheat Boga Sari catering is more profitable than raw materials elephant grass.

**Keywords:** *batch distillation; elephant grass; fermentation; hydrolysis; wheat plant liquid waste.*

### 1 Introduction

Indonesia has a climate that facilitates the growth of elephant grass, elephant grass so availability can be continuously overflow. Elephant grass is one of the underutilized crops. Today the grass is only used as animal feed, grass is also sometimes considered a nuisance plant. Elephant grass has not been fully utilized and can interfere with the environment if left alone. Indonesia has several places such as elephant grass producers in Central Java, West Java and East Java, and will be developed in several other areas, with the potential of certain sources of raw material for making ethanol will be available in large enough quantities. But the grass has content of cellulose, starch, and glucose can be used as one of the ethanol product [15].

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In conjunction with Chemical Engineering Seminar of SoehadiReksowardojo 2013

Leri water is rice water obtained in the processing of rice flour from rice, which has rice water still not fully utilized, only limited to watering plants, livestock drink or thrown away. Judging from the content of nutrients and starch content of the water leri still likely to be further processed, is one of the alternative processing into ethanol. Ethanol is made by the fermentation of yeast ingredients with rice water hydrolysis process is done in advance, long fermentation depends on the type of yeast used, initial glucose levels and the desired levels of ethanol. Very abundant availability of raw material and can be obtained continuously enabling can be used to produce ethanol continuously anyway. Waste washing rice has the carbohydrate content of 300 mg/liter at rice 2 kg, with the carbohydrate content is allowed to be used as a feedstock for ethanol production. Rice water has not been fully utilized and can interfere with the environment if left alone. Indonesia has several places producing rice water like in a restaurant, rice flour mill waste and households, with the potential of certain sources of raw material for making glucose will be available in large enough quantities [8].

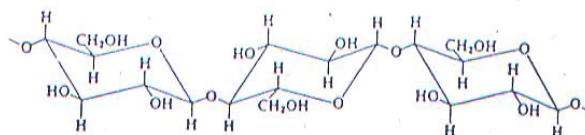
Ethanol is used in diverse industries such as mixed for sake or liquor like gin, pharmaceutical and cosmetic raw materials, and the mix of vehicle fuel, octane enhancer, ethanol gasoline (gasohol) and as a source of oxygen for a cleaner burning replacement (methyl tertiary-butyl ether/MTBE). Because ethanol contains 35 percent oxygen, can increase the efficiency of combustion. Ethanol is also environmentally friendly because of the low gas emission levels monoksidanya carbon, nitrogen oxides, and greenhouse gases are a pollutant and readily biodegradable and safe because it does not pollute the environment. Until now consume about 63 percent of world ethanol for fuel, especially in Brazil, North America, Canada, the European Union, and Australia. In Asia, Japan and South Korea are the biggest consumption of ethanol is for booze. Pemerintan program in 2025 about the use of ethanol as a fuel, ethanol production only depends on the raw material is waste molasses sugar mills, sugar mills presence in Indonesia is not growing. Drops produced does not meet the quantity, so it is necessary the development of alternative raw materials for ethanol products.

Since the Minister of Research and Technology to launch fuel Gasohol BE-10 at the end of January 2005, where the raw materials used to manufacture ethanol from cassava and maize, have a very berfluktuaktif selling price, so the selling price is much more expensive than fuel oil Government to import fuel, it shows considerable national fuel demand, while domestic production is insufficient, so often there is a shortage of fuel and fuel prices become very expensive, and the price of basic commodities go high, which resulted in disruption of the economic sector [13].

## 2 Review of Literature

### 2.1 Quality Raw Materials

Bulrush in general is an annual plant that stands erect, rooted in, high rhizome. High stems can reach 2-4 meters (even reaching 6-7 meters), with a trunk diameter can reach more than 3 cm and comprises up to 20 segments / book. Growing up with a clump forming clumps up to 1 meter wide. Leaf midrib glabrous to short-hairy, leaves striped with a wide base, pointed tip. Nutrient content per ton of dry matter is: N: 10-30 kg, P: 2-3 kg; K: 30 kg; Ca: 3-6 kg, Mg and S: 2-3 kg [15]. Other content of elephant grass are: 5.2% crude protein and crude fiber 40.85%. Cellulose is a glucose polymer-bonded  $\beta$ -1, 4 units between glucose. Cellulose serves as a structural material in plant tissue in the form of a mixture of polymer homologues and is usually accompanied by other polysakarida and lignin in various quantities. Elongated and rigid cellulose molecules, although in solution. Hydroxyl groups protruding from the chain can form hydrogen bonds with ease, resulting in kekristalan within certain limits. A high degree of kekristalan cause greatly increased elasticity modulus and tensile strength of cellulose fibers become bigger and result in food that contain more clay cellulose. Cellulose is a polysaccharide that is the highest on earth can be converted to glucose by acid hydrolysis.



**Figure 1** The formula up cellulose.

Flour mill wastewater is water leri Boga Sari, where water leri is water obtained from washing rice used to make flour, water content leri (2 kg of rice: 1 liter of water) as shown in Table 1. In Table 1 it can be seen that leri water contain organic compounds such as carbohydrates and thiamin which is a nutritional compound that can still be used for the growth of yeast that plays a role in the manufacture of ethanol [8].

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**Table 1** Leri water nutritional value.

Composition	Number (mg/l)
Fat	90.0
Protein	420.0
Carbohydrate	300.0
Calcium	20.0
Phosphorus	200.0
Iron	1.8
Vitamin B	0.9

Carbohydrates are the main source of calories for humans than protein and fat. Carbohydrates have the empirical formula  $(CH_2O)_n$  also has an important role in determining the characteristics of foods, such as flavor, color, texture, and others. Carbohydrates are useful for preventing excessive body protein breakdown, loss of minerals and useful to help metabolize fats and proteins. In nature, carbohydrates formed from the reaction of  $CO_2$  and  $H_2O$  with the help of sunlight through the process of photosynthesis in plant cells that chlorophyll, while the ingredients that are a source of carbohydrates obtained from the roots and stems of plants such as corn, grass, bagasse [7]. Carbohydrate is the staple food in many Indonesia parts are grains, especially rice and corn.

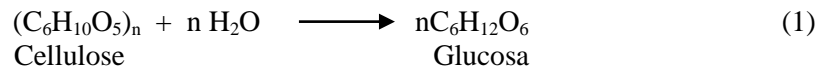
In general, carbohydrates can be grouped into three sections: monosaccharides, is a molecule that consists of 5 or 6 C atoms, containing one aldehyde group called aldose, while ketosa have a ketone group, monosaccharides with 6 carbon atoms called hexoses, such as glucose (dextrose / grape sugar), while having 5 C atoms are called pentoses, eg xylose, arabinose and ribose. Oligosaccharides, are polymers of monosaccharides 2-10, are usually soluble in water, oligosaccharides consisting of 2 monosaccharide molecules called disaccharides, is an example of the disaccharide sucrose, oligosaccharides can be obtained from the hydrolysis of polysaccharides with the help of enzymes or acid hydrolysis. Polysaccharide, composed by many monosaccharide molecules, the food texture serves as a reinforcing material (cellulose, hemicellulose, pectin and lignin) and as a source of energy (starch, glycogen, fructan) [10].

## 2.2 Hydrolysis Process

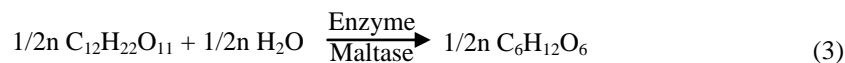
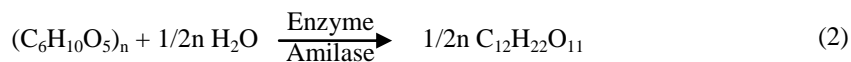
Acid hydrolysis is by using acid hydrolysis to convert polysaccharides (starch, cellulose) into sugars, typically used hydrochloric acid (HCl) or sulfuric acid ( $H_2SO_4$ ) with certain levels. Hydrolysis is usually done in a special tank made of stainless steel or copper pipe connected to the heating ducts and exhaust pipes to regulate the pressure in the air [9]. Cellulose of grass can be converted

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into ethanol by acid hydrolysis process to some degree. Cellulose hydrolysis process must be carried out with concentrated acid to produce glucose [3]. Hydrolysis process is influenced by several factors, including: pH affects the hydrolysis process so that it can be produced hydrolysis as expected, a good pH for hydrolysis was 4.5 [9]. Temperature also affects the speed of the hydrolysis reaction, good temperature for hydrolysis of cellulose is about 21°C. Concentrated HCl or H<sub>2</sub>SO<sub>4</sub> concentration affects the rate of reaction of concentrated acid hydrolysis. In the process of hydrolysis, the cellulose in the grass is converted into glucose by the reaction:



Starch is a component that is more complex than a disaccharide, before fermentation, starch must be broken by using the enzyme amylase into the disaccharide maltose component. By using enzymes, maltase and maltose would hydrolysis to glucose [12].



Hydrolysis process is influenced by several factors, including the amount of carbohydrate in raw materials, operating pH or the concentration of the acid used, hydrolysis time, hydrolysis temperature and catalyst.

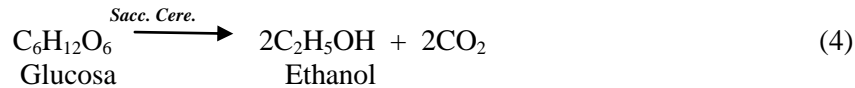
### 2.3 Fermentation Process

The fermentation process is carried out is the fermentation process that does not use oxygen or anaerobic processes. To control the production of ethanol from sugar is quite complex, the concentration of substrate, oxygen, and ethanol products, all cerevises *Saccharomyces* affecting metabolism, cell survival, cell growth, cell division, and ethanol production. *Saccharomyces cerevisiae* suitable selection and have a high tolerance for both concentrations, alcohol substrate is important for improving yields [1]. Fermentation was the first time the basic treatment of the seed fermentor or starter preparation. Where the starter inoculated until completely incorporated into the fermenter ready, put in new substrate to be fermented [2].

Seed fermentor used was *Saccharomyces cerevisiae*. The fermentation process is influenced by the process of fermentation, mikroorganisme really need good

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nutrition in order to obtain a good fermentation. Proper nutrition is to supply nitrogen microorganisms which can be obtained from the addition of  $\text{NH}_3$ , ammonium salts, peptone, amino acids and urea. Nitrogen is needed for liquid L gram/1000 400-1000. Phosphate is needed for 400 gram/1000 L fluid [9]. Other nutrients are ammonium sulfate with gram/100 70-400 liters of fluid levels [5]. Good pH for bacterial growth is 4.5 to 5. But at pH 3.5, fermentation can still run well and spoilage bacteria inhibited, can be used to adjust the pH of NaOH and  $\text{HNO}_3$ . A good temperature for bacterial growth is between 20-30 oC. The lower the fermentation temperature, the higher the ethanol that will be produced, because at low temperatures will be more complete fermentation and ethanol loss carried away by the  $\text{CO}_2$  gas will be less. The time needed for fermentation was 7 days [5]. The sugar content will be very mempengaruhi fermentation process, given optimum sugar content for fermentation is 25%, for starters, the sugar used is 16% [10]. Volume a good starter for fermentation is 1/10 part of the substrate volume. In the fermentation process, fermentation of glucose is converted into ethanol by the following reaction:



### 2.3 Proses Distilasi Batch

In the separation of multicomponent systems, it is assumed that perfect mixed liquida where  $x_w = x_i$  and  $y_D = y_i$ , than [4]:

$$\frac{dx_i}{dt} = (y_i - x_i) \frac{dW}{W dt} \quad (5)$$

Where: at the bottom liquida composition ( $x_w$ ), the composition of liquida component i ( $x_i$ ), the composition of the vapor in the distillate ( $y_D$ ) and the composition of the vapor component i ( $y_i$ ).

With initial conditions:  $x = x_0$  dan  $W = W_0$ , then integrable into:

$$\int_{x_0}^x \frac{dx_i}{(y_i - x_i)} = \int_{w_0}^w \frac{dW}{W} = \ln \left( \frac{W}{W_0} \right) \quad (6)$$

$$\frac{dx_i}{(y_i - x_i)} = d \ln \left( \frac{W}{W_0} \right) \quad (7)$$



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$$\xi = \ln \left( \frac{W_o}{W} \right) \quad (8)$$

Where,  $\xi$  = dimensionless number that depends on time, so obtained equation is substituted:

$$\frac{dx_i}{(y_i - x_i)} = d\xi \quad (9)$$

The above equation is a model Differential-Algebraic-Equations (DAEs) for simple batch distillation of multi-component systems, assuming no phase forming two liquida. The above equation is the forward-finite-difference, will be obtained in the bottom liquida composition ( $x_{i,j+1}$ ) as a function of  $\Delta\xi$ , thus obtained as follows [6]:

$$x_{i,j+1} = x_{i,j} + (y_{i,j} - x_{i,j}) \Delta\xi \quad (10)$$

Where the composition of the early liquida at bot ( $x_{i,j}$ ) dan  $\Delta\xi$  determined, while the composition of the vapor ( $y_{i,j}$ ) is calculated using equation BUBL T [4].

### 3 Research Methods

Based on Figure 3 above bioethanol production to produce bioethanol needs to assess the quality of some of the parameters that influence such as: the degree of acidity (pH), the volume ratio of HCl to the elephant grass and the volume of wastewater that is used, the added volume cereviceae *Saccaromyces*, long fermentation time is required, long time batch distillation is required. Analysis of the quality of raw materials and products of bioethanol done with laboratory analysis, the analysis was conducted on the instrumentation and gravimetric analysis. Instrumentation for analysis using Gas Chromatography (GC) and Spectrophotometer, include: starch, glucose, ethanol concentration, HCl concentration, levels of crude protein and the remaining N, P, K, Ca, Mg, S. For gravimetric analysis include: pH, temperature and volume of raw materials.

Hvdrolysis

Fermentation

Distillation

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**Figure 2** The series of bioethanol production tools

Analysis of the concentration (cellulose, starch, glucose), and then enter the elephant grass and liquid waste (according to treatment) into the stirred tank reactor with a certain volume. Enter HCl solution with a certain concentration and did the stirring speed 200 rpm, the stirring is done in a certain time, separate the solids formed from the mother liquor. Wash the solids with water, wash water ratio / certain solids, separate the solids from the liquid, the dry solids at a given temperature and time, concentration analysis of cellulose, starch, glucose and HCl.

## **4 Results and Discussion**

### **4.1 Quality Raw Materials**

Elephant grass used as study materials derived from elephant grass crops are planted alongside farmland, which was in the area of Malang, Kediri and East Java. Assessment method is to do a survey and laboratory analysis to obtain data on the quality and quantity of grass available. The expected result is data about the quality and quantity of grass prior to the process to be ethanol [15]. Carbohydrates are the main source of calories for humans than protein and fat.

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In conjunction with Chemical Engineering Seminar of SoehadiReksowardojo 2013

Carbohydrates have the empirical formula  $(CH_2O)_n$  also has an important role in determining the characteristics of foods, such as flavor, color, texture, and others. Carbohydrates are useful for preventing excessive body protein breakdown, loss of minerals and useful to help metabolize fats and proteins. In nature, carbohydrates formed from the reaction of  $CO_2$  and  $H_2O$  with the help of sunlight through the process of photosynthesis in plant cells that chlorophyll, while the ingredients that are a source of carbohydrates obtained from the roots and stems of plants such as sago [7]. Carbohydrate is the staple food in many Indonesia parts are grains, especially rice and maize.

#### 4.1.1 Quality Elephant Grass

The results of laboratory analysis, it is known that the number of elements forming ethanol is cellulose, glucose and starch. For cellulose levels by an average of 48.055 %, glucose levels by an average of 4.836 % and an average starch content of 20.367 %. If the entire cellulose can be hydrolyzed completely, it will obtain the glucose levels of 52.891 %. In the grass there are still about 20.367 % unprocessed starch into glucose, will be a further process. If the grass is perfect hydrolyzed, then the elephant grass contained 100 grams of cellulose or 48.055 grams  $(48.055/162) = 0.2966$  mol mol, 52.891 grams of glucose or  $(52.891/180) = 0.2938$  mol mol. According to reaction (2), if the perfect fermentable glucose to ethanol levels obtained by 2 times  $0.2966$  mol =  $0.5932$  mol or 27.287 grams and  $0.5932$  mol of  $CO_2$  or 26.101 grams [15].

**Table 2** Quality of elephant grass

No.	Parameter	Concentration 1 (%)	Concentration 2 (%)	The average concentration (%)
1	Cellulose	48.08	48.102	48.055
2	Glucosa	4.774	4.898	4.836
3	Starch	20.318	20.416	20.367
	TOTAL	73.100	73.416	73.258

Cutting grass with a length of approximately 5 cm to obtain high levels of glucose and cellulose can be hydrolyzed with HCl solution. Grass should be made in the form of powder, so that cellulose can be hydrolyzed perfect, but it takes a higher cost. Besides, it also dikwatirkan elephant grass that occurs in the form of powder physical destruction, thus causing defective glucose group. Drying grass naturally made in advance with the room temperature, after 2-3 days was drying in an oven at  $100\text{ }^{\circ}C$  for 3 hours, this was done for cost savings. Drying is a process that aims to reduce the water content in ethanol, water levels permitted by SNI of 1% [15].

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#### 4.1.2 Liquid Waste Quality Rice Flour

The results of laboratory analysis, it is known that the number of elements forming bioethanol (glucose and starch), starch for an average of 9.282 %, this means that if all produced completely hydrolyzed glucose obtained in large quantities. In 100 liters of liquid waste flour mill can produce a maximum of 9.282 liter glucose. Besides starch, glucose is also present in the flour mill effluent Boga Sari large numbers. In 100 grams of flour mill wastewater can be generated Boga Sari maximum of 3,786 liters of glucose. Given the composition of high glucose and starch in the flour mill waste water, the hydrolysis process is expected to run perfectly, so that the amount of glucose and starch completely degraded to glucose by 12.568 liters. Filtering flour mill effluent performed using gauze, filtering is done repeatedly to obtain a clean result prior to hydrolysis. In addition to filtering naturally carried deposition with silence for a while, so naturally tersidimentasi, the filtrate was taken and we use compost sediments [8].

**Tabel 3** Liquid effluent quality Boga Sari Flour Factory

No	Parameter	Concentration 1 (%)	Concentration 2 (%)	The average concentration (%)
1	Glucosa	1,776	2,898	3,786
2	Starch	9,148	9,416	9,282
	Total	10,924	12,314	12,568

Effect of pH on the addition of HCl volume, where the greater the additional volume of HCl pH decrease. Due to the fermentation process required the addition of pH 4.5 HCl volume by 7% the closest, for varying the volume of waste water. Prior to the hydrolysis process, the filtrate pH was measured according to the terms fermentation process that is approximately 4.5. To obtain pH 4.5, the addition of NaOH when the pH of the filtrate under 4.5 and the addition of citric acid if the pH above 4.5 filtrate

#### 4.2 Hydrolysis Process

Commonly used in acid hydrolysis, hydrochloric (HCl) or sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) with certain levels. Hydrolysis is usually done in a special tank made of stainless steel or copper pipe connected to the heating ducts and exhaust pipes to regulate the pressure in the air [9]. Cellulose of grass can be converted into ethanol by acid hydrolysis process to some degree. Cellulose hydrolysis process must be carried out with concentrated acid to produce glucose [3]. Starch is a component that is more complex than the disaccharide. Prior to fermented, starch must be broken by using the enzyme amylase into the

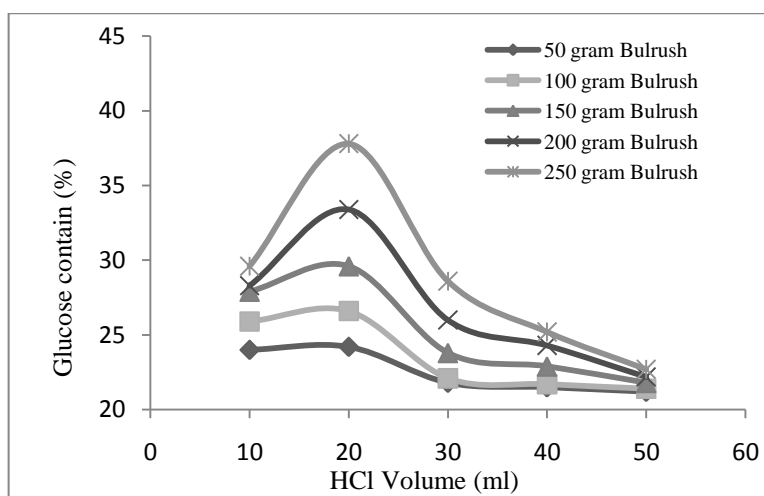
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component disaccharide maltose. By using another enzyme, namely maltase, maltose hydrolyzed to glucose [12].

#### 4.2.1 Hydrolysis Elephant Grass

Hydrolysis process is done by varying the weight of elephant grass: 50 100, 150, 200, 250, 300 grams with the addition of HCl volume varied: 10, 20, 30, 40, 50 ml. After the extraction process is complete and the solids obtained filtrate, the filtrate will be processed in the fermentation process to obtain ethanol concentration and solids can be used as compost. Filtrate pH was measured according to the terms fermentation process that is approximately 4.5; limited to a minimum pH of 3.5 due to the condition *saccharomyces cereviceae* still survive. To maintain pH 4.5, the addition of NaOH, pH when filtrate under 4.5 and the addition of citric acid if the pH of the filtrate is above 4.5.

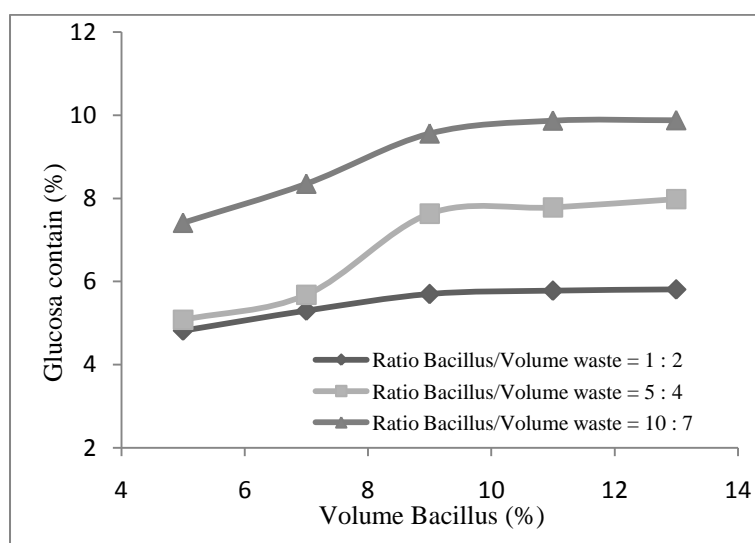
Effect of pH on the addition of HCl volume, where the greater the additional volume of HCl pH decrease. Because the pH of the fermentation process required the addition of 4.5 volume of 20 ml of HCl is the most likely, for a variety of heavy grass. Prior to the fermentation process, the filtrate was measured optimum glucose levels of approximately 16%, if the glucose level is more than 16% dilution, if the glucose level is less than 16%, the addition of glucose.



**Figure 3** Effect of the addition HCl volume on glucose contains in the elephant grass

### 4.2.2 Hydrolysis Liquid Waste

Hydrolysis process is done with the Bacillus ratio varies the volume of waste; 1:2; 5:4; 10:7 with the addition of varying volumes of Bacillus: 5, 7, 9, 11, 13 (% v / v). Once the process is complete hydrolysis obtained filtrate and solids, the filtrate will be processed in the fermentation process to obtain ethanol concentration and solids can be used as compost. Prior to the fermentation process, the filtrate was measured optimum glucose levels of approximately 16%, if the glucose level is more than 16% dilution, if the glucose level is less than 16%, the addition of glucose.



**Figure 4** Effect of volume bacillus addition to glucose cantain in the liquid waste

Figure 4 gained influence glucose levels against bacillus volume expansion, where the greater the additional volume of bacillus greater glucose levels. On the addition of Bacillus volume above 9% graph shows a constant profile, because bacillus performance began to decline and die over time, so it is necessary to regenerate bacillus. The addition of bacillus volume between (3-9) % showed increased glucose levels, as it is the growth phase bacillus, thus optimally decompose starch into glucose.

### 4.3 Fermentation Process

The fermentation process is carried out is the fermentation process that does not use oxygen or anaerobic processes. To control the production of ethanol from sugar is quite complex, the concentration of substrate, oxygen, and ethanol

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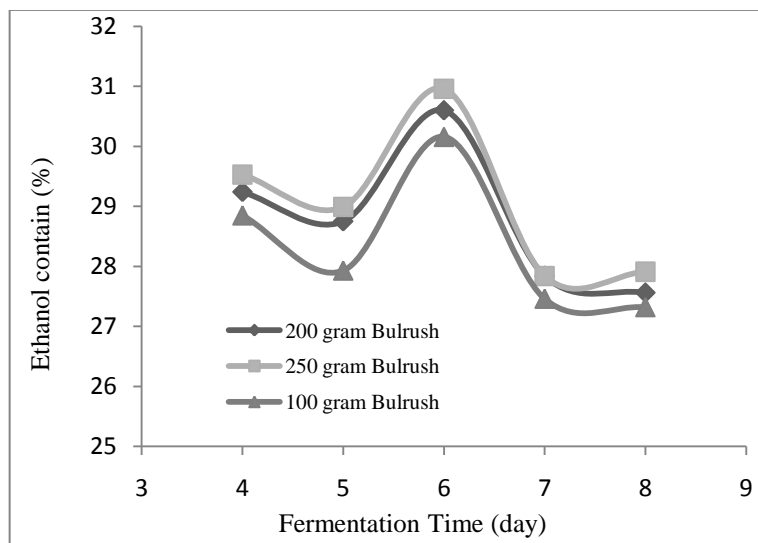
products, all affect yeast metabolism, cell survival, cell growth, cell division, and ethanol production. Selection of yeast strains suitable, have a high tolerance for both concentrations, or alcohol substrate is important for improving yields [11]. Fermentation was the first time the basic treatment of the seed fermentor / prep starter. Where the starter inoculated until completely ready to fermenter, put in new substrate to be fermented [2]. Seed fermentor used was *Saccharomyces cerevisiae*.

#### **4.3.1 Fermentation Filtrate of Elephant Grass**

The process of fermentation filtrate from the hydrolysis of elephant grass and then the addition of a starter (liquid *Saccharomyces cerevisiae*) 8, 10, 12%. With fermentation time 4, 5, 6, 7, 8 days rest will be obtained glucose levels, levels of ethanol and HCl levels. After analysis glucose levels in the rest of the fermentation process, with the addition of starter number 10% of the volume of fluid (filtrate) showed a small residual glucose levels compared to the addition of starter 8 and 12%. At the time of 5 days of fermentation the maximum residual glucose levels, because it is still a process of adjustment *Saccharomyces cerevisiae*. At the time of fermentation time 6 days showed minimum residual glucose levels, because at the time it occurred *Saccharomyces cerevisiae* optimum performance, after 6 days of fermentation glucose levels above the rest of the greater because the performance has weakened bacteria, usually performed regeneration *Saccharomyces cerevisiae*.

It also conducted a content analysis of HCl in the fermentation process, with the addition of starter number 10% of the volume of fluid (filtrate) showed higher levels of HCl is at least 6 days fermentation time. This is because already done preliminary research and according to the Journal a good fermentation time is 6 days. 6 days fermentation time is best for optimum phase of *Saccharomyces Cerevisiae*, 6 days under an adjustment or growth *Saccharomyces Cerevisiae* and after 6 days of regeneration or change of phase *Saccharomyces Cerevisiae*.

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**Figure 5** Effect fermentation time on ethanol contain

After analysis Ethanol concentration in the fermentation process with the addition of 10 % of the amount of starter fluid volume showed higher levels of ethanol than the addition of starter 8 and 12 %. This is because already done preliminary research, in preliminary research gained 9 % ethanol content. After the improvement in the process of hydrolysis and fermentation processes, the maximum ethanol concentration obtained at 6 days of fermentation at 31.69 %.

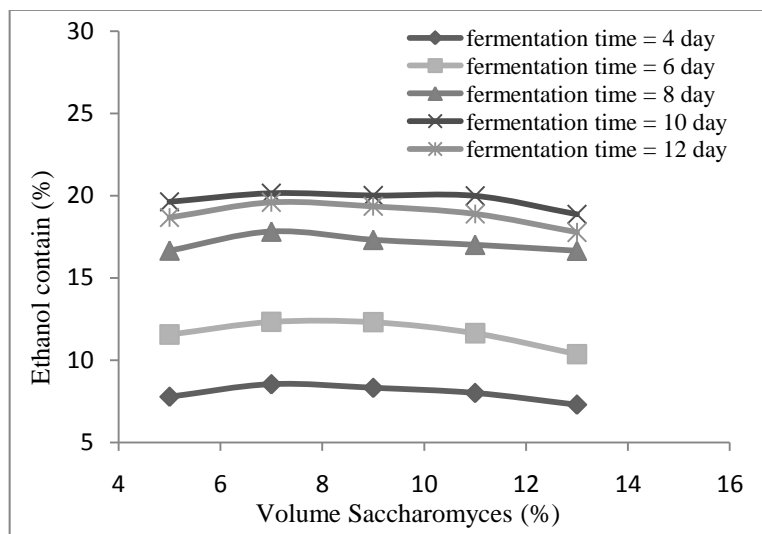
#### **4.3.2 Fermentation Filtrate Liquid Waste**

Filtrate fermentation process wastewater from rice flour ratio of the volume of waste varies Bacillus namely: 1:2; 5:4; 10:7 with the addition of varying Saccaromyces Sereviceai: 5, 7, 9, 11, 13, (% v / v) with fermentation time 4, 6, 8, 10, 12 days. For the fermentation process used variable ratio of the volume of waste water Bacillus ie 1:2 5:4 10:7. Each ratio of the volume of wastewater Bacillus each sought glucose and starch content of the rest.

Filtrate rate influences the residual glucose levels, for a number of starter saccaromyces cereviceae 6, 9, 11 and 13% v / v, obtained maximum residual glucose levels (1,3 - 3) The%, this is because in the tank hydrolysis reactor and the amount of filtrate starter saccaromyces cereviceae still little, so that the fermentation process is not optimal. With the increasing amount of filtrate hydrolysis and starter saccaromyces cereviceae then the smaller the residual glucose, because it is fermented into ethanol.



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**Figure 6** Effect Saccharomyces volume on the remaining ethanol contain

After analysis glucose levels in the rest of the fermentation process, with the addition of Saccharomyces 7 % of the volume of fluid (filtrate) showed a small residual glucose levels compared to the addition of starter 6, 9, 11 and 13 %. This is because the preliminary research has been conducted in accordance with the Journal and the addition of 7% of the fluid volume. Filtrate rate influences the residual glucose levels, for a number of starter saccaromyces cereviceae 6, 9, 11 and 13%, obtained maximum residual glucose levels (1.5 - 5)%, this was due to the amount in the tank reactor filtrate hydrolysis and starter saccaromyces cereviceae still little, so that the fermentation process is not optimal. With the increasing amount of filtrate hydrolysis and starter saccaromyces cereviceae then the smaller the residual glucose, because it is fermented into ethanol.

#### 4.4 Batch Distillation Process

Ethanol is derived from the fermentation process and then performed a mini-scale batch distillation process plant, by selecting the best conditions of the fermentation process, at the time of fermentation 10 days. Ethanol contain obtained by the distillation of batch plant mini scale shows the range of (95-96) % and the yield (31.66 to 33.3) %. Economically to be commercialized because the required technical ethanol 95% and the resulting yield is also quite high.

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**Tabel 4** Ethanol contain and Yield on mini-scale batch distillation process plant

Ratio HCl against Raw materials	Volume Saccharomyces (%v/v)	Kadar Glucosa (%)	Kadar Ethanol, Fermentation (%)	Kadar Ethanol, Distillation batch (%)	Yield (%)
1 : 2	5	4.82	19.63	91.5	30.5
	7	5.30	20.15	93	31,8
	9	5.70	20.01	94	32.3
	11	5.78	19.99	92.5	31.6
	13	5.81	18.87	91	32.3
5 : 4	5	5.08	18.63	92	30.2
	7	5.68	20.46	94.5	31.8
	9	7.63	20.88	96	33.3
	11	7.78	19.33	95	32.6
	13	7.98	18.27	94	32.1
10 : 7	5	7.41	19.63	94	30.4
	7	8.35	21.9	94.5	32.8
	9	9.56	20.44	95	33.1
	11	9.87	19.66	94.5	32.9
	13	9.88	18.77	93	32.6

#### 4.5 Economic Analysis

In 100 grams of grass there are 48.055 grams of cellulose, glucose generated in 0.2966 mole where  $0.2966 \text{ mole} \times 180 = 53.388 \text{ grams}$ . While the ethanol produced is  $2 \times 0.2966 \text{ mole} = 0.5933 \text{ mole}$  or  $0.5933 \times 46 = 27.291 \text{ grams}$ .  $\text{CO}_2$  produced  $2 \times 0.2966 \text{ mole} = 0.5933 \text{ mole}$  or  $0.5933 \times 44 = 26.105 \text{ grams}$ . Yeild ethanol produced is 61.69%. In 100 grams of grass there are 61.69 grams of ethanol; elephant grass in 1000 grams 616.9 grams of ethanol contained in 1 kg of elephant grass contained 616.9 grams of ethanol, ethanol density = 0.98 g/liter, resulting in a 1 kg bulrush obtained  $616.9 \text{ grams} / 0.98 \text{ (g/ml)} = 629.5 \text{ mL}$  or 0.6295 liters. Cost needs to cultivate grass in 1 k gram is: Bulrush price is Rp. 60/kg. HCl Price: IDR 3000/liter; 1 kg of elephant grass to take  $20 \text{ ml} \times 4 = 80 \text{ m liters}$ , so it will cost  $80/1000 \times \text{Rp. } 3000 = \text{Rp. } 240$ . Assuming electricity costs 1% of the product price (IDR 22,000) = Rp 220. Labor costs assuming 2% of the product price (IDR 22,000) = IDR 440. Other costs assuming 1% of the product price (IDR 220) = IDR 220. So the base price of ethanol product is IDR 1,180

In 100 grams of Liquid Waste contained 9.282 grams of starch, glucose generated in 0.0573 mole where  $0.0573 \text{ mol} \times 180 = 30.313 \text{ grams}$ . While the

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ethanol produced is  $2 \times 0.0573 \text{ mole} = 0.1146 \text{ mole}$  where  $0.1146 \times 46 = 5.27$  grams.  $\text{CO}_2$  produced  $2 \times 0.0573 \text{ mole} = 0.1146 \text{ mole}$  where  $0.1146 \times 44 = 5.042$  grams. Yield ethanol produced is 33.3%. In 100 grams of liquid waste in rice flour 33.3 grams of ethanol, in 1000 grams Rice Flour Wastewater contained 333 grams of ethanol, in a 1 kg liquid waste in rice flour contained 333 grams of ethanol, resulting in a 1 kg liquid waste in rice flour obtained 333 grams/ $0.98 \text{ (g/ml)} = 339.796 \text{ ml}$ , ethanol products produced 339.796 ml or 0.3398 liters. Cost needs to process the liquid waste in rice flour 1 kg is, liquid waste in rice flour price is IDR 0 / kg. Bacillus Price: IDR 3000/liter; Liquid waste in rice flour to 1 kg take 20 ml  $\times 4 = 80 \text{ ml}$ , so it will cost  $80/1000 \times \text{Rp. } 3000 = \text{IDR } 240$ . Assuming electricity costs 1% of the product price (IDR 22,000) = Rp 220. Labor costs assuming 2% of the product price (IDR 22,000) = IDR 440. Other costs assuming 1% of the product price (IDR 220) = IDR 220. So the base price of ethanol product is IDR 1,120.

## 5 Conclusion

Glucose levels obtained in the process of hydrolysis, 37.8% for grass and 9.98% waste flour, levels of ethanol in the fermentation process equal 16 to 20.88) %. Processed from raw materials to produce bio-ethanol Showed that the levels of (95-96)% with a yield (31.69-33.3)%, by knowing comparison process, in order to Obtain scale distillation column design mini scale plant with 100 liters of ethanol / day in 3 batches. Raw materials economically liquid waste plant wheat Boga Sari catering is more profitable than raw materials elephant grass.

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